Bitcoin ETFs: On the Struggle to Get It Right

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ABSTRACT

Spot bitcoin can be worthwhile incrementally to a long-term investment portfolio. Its returns are uncorrelated with traditional asset classes. Spot bitcoin ETFs are the safest, most familiar, and most convenient investment method. Bitcoin futures and futures-based bitcoin ETFs are inferior substitutes – futures because the bitcoin futures market is in persistent contango, and futures-based bitcoin ETFs because they add a layer of management fees and replication strategy risk. The struggle to bring spot bitcoin ETFs to market took over a decade in the U.S., with the inferior products launched first. The deliberations in other global markets varied in terms of aim and action. Such is the nature of regulatory decision-making in the U.S. and elsewhere. Hopefully, future innovation can be eased by better education and thoughtful collaboration.

Keywords: bitcoin, spot bitcoin, bitcoin futures, bitcoin ETFs, contango, creation/redemption arbitrage, futures arbitrage

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The pace of financial innovation in the last five decades has been extraordinary. The 1970s saw the launch of foreign exchange and long-term interest rate futures contracts, the 80s short-term interest rate futures and stock index futures and options, and the 90s volatility futures and options. Together, these launches have fundamentally changed the way financial markets run. Hundreds of billions of dollars of these contracts are traded each day. Today, they are taken for granted, as if they were always there. Largely forgotten are the struggles of the entrepreneurs and exchanges who brought these products to market. They fought long and hard (sometimes for more than a decade) to educate regulators and convince them of the social value of these contracts.

This paper focuses on innovation and regulation in the exchange-traded fund (ETF) industry. Much has happened since the ETF industry was inaugurated worldwide with the launch of the TIPs ETF in Canada in 1990. Three years later, the SPY ETF was launched in the U.S. The struggle with regulators and entrenched market authorities in the U.S. took six years before SPY was approved. The need for real-time stock basket trading was named in the aftermath of the 1987 Stock Market Crash.

Spot bitcoin ETFs, a recent addition to the U.S. market, were launched more than ten years after the first filing was made at the SEC. This begs the question- why did it take so long? Did other countries face similar delays? Understanding the development of spot bitcoin ETFs from a global perspective is not just informative but crucial. How quickly were these products developed, and how supportive were regulators? It's clear that spot bitcoin, with returns uncorrelated with traditional asset classes, can be a valuable diversifier for long-term investment. So, why was its progress impeded, and how does this delay affect the global market?

The paper is divided into five sections. Section 1 provides the history of bitcoin and describes its intended uses. Section 2 describes the cryptocurrency exchange markets where spot bitcoin was initially traded. Section 3 explains the motivation for developing spot bitcoin ETFs. They provide a safer, more convenient, and more familiar trading environment. Innovators worldwide recognized their value and fought for their introduction. We describe the struggles in the U.S., Canada, Australia, and Europe, underscoring the global nature of these challenges. With the U.S. struggle behind us, Section 4 focuses on where we are about exchange-traded bitcoin products in the U.S. There are three—spot bitcoin ETFs, bitcoin futures, and futures-based bitcoin ETFs. We provide theoretical arguments and empirical evidence to support our conclusion that spot bitcoin ETFs are the dominant structure. Section 5 summarizes the main findings of the paper.

1. Brief history of bitcoin

Cryptocurrencies are decentralized digital money designed to be used over the internet. Bitcoin was the first offering. It was launched in 2008 and is still the largest cryptocurrency market. Others include Ethereum, Tether, and BNB in descending order of market capitalization. Table 1 has the list as of June 2, 2024.

Table 1: Cryptocurrency market capitalizations on June 2, 2024. Source: Coinmarketcap.com

Cryptocurrency	Market cap in billions of USD
Bitcoin	1,341
Ethereum	455
Tether	112
BNB	92
Solana	75
USDC	32
XRP	28
Dogecoin	23
Cardano	16
Toncoin	16

The motives for holding bitcoin are many. First, it makes it possible to transfer value online without needing an intermediary like a bank or payment processor, allowing value to transfer globally, near-instantly, 24/7, and for low fees.[1] Second, cryptocurrencies are managed by peer-to-peer networks of computers running free, open-source software. They are not issued or controlled by any government or other central authority. Third, a cryptocurrency blockchain is like a bank's balance sheet or ledger. Each currency has its own blockchain, an ongoing, constantly re-verified record of every transaction using that currency. Fourth, unlike a bank's ledger, a cryptocurrency blockchain is distributed across participants of the digital currency's entire network. Fifth, anyone with an internet connection or internet access can take part.

The primary driver of bitcoin's value is that it offers a safe, secure, low-cost payment system. Bitcoin's price, however, is another matter. Supply will always be at most 21 million, and 19.7 million exist today. What that means is that bitcoin's price is decided by trading demand. Since supply is fixed, daily price movements are driven by traders' daily net trading demand. With more buyers than sellers, the price goes up; with more sellers than buyers, the price goes down. The fact that bitcoin's price is so volatile is not driven by the uses described above. It is also used for placing short-term directional bets (i.e., as a speculative trading tool). How the speculators formulate their intra- and inter-day price predictions is impossible to know. Undoubtedly it is based on something other than fundamentals. Bitcoin does not generate cash flows of any sort. It is a bet that today's buyer (seller) can sell (buy) at a greater (lesser) price in the future when they unwind the position.

From a purely trading or investment perspective, the interest in bitcoin is twofold. Some want to speculate. These traders make short-term bets – a few days

[1] See Nakamoto (2008).

or less – to satisfy their desire to make directional bets. Others want to diversify. These are individuals interested in managing their long-term wealth for consumption purposes (e.g., a retirement plan) or institutions interested in providing current income while at the same time preserving wealth overall (e.g., a university endowment). These entities are interested in knowing whether bitcoin is a practical asset class and should be included in their long-term investment holdings.

2. Cryptocurrency markets

Cryptocurrency exchanges are the original way to trade bitcoin. There are many types. Some allow users to remain anonymous (i.e., do not require users to enter personal information) and are decentralized. Popular U.S. exchanges (e.g., Coinbase, Kraken, Gemini) are centralized and require users to submit identifying documentation.

Centralized exchanges (CEXs) run like well-known electronic stock exchange brokerage platforms. Using CEXs, users can trade cryptocurrencies for other cryptocurrencies and fiat. The exchanges handle transactions using an order book that mirrors the mechanisms used at stock exchanges such as the NYSE and Nasdaq while often offering services such as margin trading. Regulations are more pronounced in CEXs than decentralized exchanges (DEXs), as the exchanges have built-in mechanisms and protocols for detecting and pursuing fraudulent activity and must follow SWIFT[2] Know Your Customer (KYC) and Anti-Money Laundering (AML) regulations. CEXs are also typically viewed as more user-friendly than their decentralized counterparts, providing higher liquidity, faster trade execution, and smaller bid-ask spreads. However, the private keys of users' wallets stay on the exchange and thus reveal a potential hacking threat.

[2] SWIFT stands to the Society for Worldwide Interbank Financial Telecommunications. SWIFT powers most international money and security transfers.

Decentralized exchanges (DEXs) allow direct transactions between market participants on peer-to-peer networks. These exchanges illuminate the early goals of cryptocurrencies in their ability to promote financial services and transactions without third-party involvement, an endeavor collectively known as decentralized finance (DeFi). Cryptocurrency wallets store assets for individuals taking part in these markets, and transactions are exclusively cryptocurrency-for-cryptocurrency with no fiat transactions. Transactions are recorded directly on the blockchain on DEXs, compared to internally (the "tape") on CEXs.

DEXs offer certain advantages over centralized exchanges that appeal to specific users. On DEXs, users keep custody of their assets without transferring them to a third party. They can trade without creating an account or providing personal information. The range of tokens available for trading is not limited, and anyone with internet access can take part.

DEXs also come with disadvantages compared to CEXs, however. These include lower liquidity, potential trading of questionable coins, and a higher requirement for users to understand transaction details to avoid errors such as sending tokens to incorrect addresses. Additionally, issues can arise with the smart contract protocols upon which DEXs rely.

Online brokers like Robinhood provide cryptocurrency trading services. Robinhood offers commission-free trading by earning revenue through volume rebates from trading venues. To sign up and trade on Robinhood, customers must verify their identity and be legal U.S. residents with a valid social security number. In contrast, some other popular online brokers like Charles Schwab do not facilitate direct cryptocurrency trading. Instead, they offer access to cryptocurrencies indirectly through ETFs, coin trusts, futures, and related stocks such as Coinbase and MicroStrategy.

3. Stock market trading and the struggle to list spot bitcoin ETFs

Spot bitcoin ETFs were launched in the U.S. in January 2024, three years after Canada. Australians launched in June 2024, five months after the U.S. (and receiving the implicit reassurance of the U.S market success). The Europeans continue to prohibit spot bitcoin ETFs, forcing the development of sub-optimal trading structures like exchange-traded products (ETPs) and notes (ETNs).

This section begins with a discussion of why stock market spot bitcoin ETFs are a superior mechanism for holding spot bitcoin than holding the cryptocurrency itself. We then go ahead through the spot bitcoin listing attempts experienced in different venues worldwide. By sorting through these details, we can glean what eases, and what impedes, financial innovation in an environment in which regulators are charged with the duty of investor protection.

3.1 Securities markets vs cryptocurrency markets

The Securities Exchange Act of 1934, enforced by the Securities and Exchange Commission (SEC), governs securities transactions in secondary markets. This Act grants the SEC authority to regulate the securities industry, including the registration, oversight, and regulation of brokerage firms offering securities services. All securities exchanges in the United States, such as the New York Stock Exchange (NYSE), NASDAQ, and Chicago Board Options Exchange (CBOE), run as self-regulatory organizations (SROs) under the SEC's supervision.

The SEC's powers, established by the Act, include requirements for periodic reporting by publicly held companies. These reports, such as annual reports (Form 10-K), quarterly reports (Form 10-Q), and event-based reports (Form 8-K), provide essential information to investors, promoting transparency in the securities traded on regulated exchanges.

Brokers who offer stock trading gather extensive personal information from customers to verify their identities and follow government and SRO regulations.

According to SEC Rule 17a-3(17), brokerage firms must keep detailed records for each account. These records include the customer's full name, social security or taxpayer identification number, address, phone number, date of birth, occupation, employment status, annual income, net worth, and investment goals. This collection of information serves to prevent fraud and allows brokers to assess a customer's financial circumstances. It also helps brokers recommend suitable securities based on the customer's investment goals.

The laws and regulations mentioned above can help alleviate the psychological burden of investment transparency for customers. Stock market trading avoids many issues that can arise on cryptocurrency exchanges. Although large, centralized cryptocurrency exchanges like Coinbase implement safeguards against fraud by adhering to SWIFT KYC and AML regulations, there are still risks associated with losing cryptocurrency assets due to lack of control over private keys – a risk absent in stock trading.

Understanding fees in stock trading is also more straightforward. Most brokers provide a transparent fee schedule, offering zero trading commissions on stocks and flat fees on other instruments such as options and over-the-counter equities. In contrast, cryptocurrency exchanges have more complex fee structures. For example, Coinbase uses a maker-taker model. Taker fees range from 0.05% to 0.60% and maker fees from 0.00% to 0.40%. Somone crossing spreads on a two-way transaction could have execution fees alone more than 1.00%.

Decentralized exchanges suffer from the issues previously discussed (low liquidity, dubious coins, etc.), which stock exchanges do not. Stock trading does not involve the complexities of understanding intricate user interfaces, the inability to trade with fiat, or liquidity issues, which are common in DEXs. Instead, stock trading involves setting up an account with a broker, making a deposit, and executing trades through user-friendly web interfaces, all while relying on well-established laws and regulations for assurance.

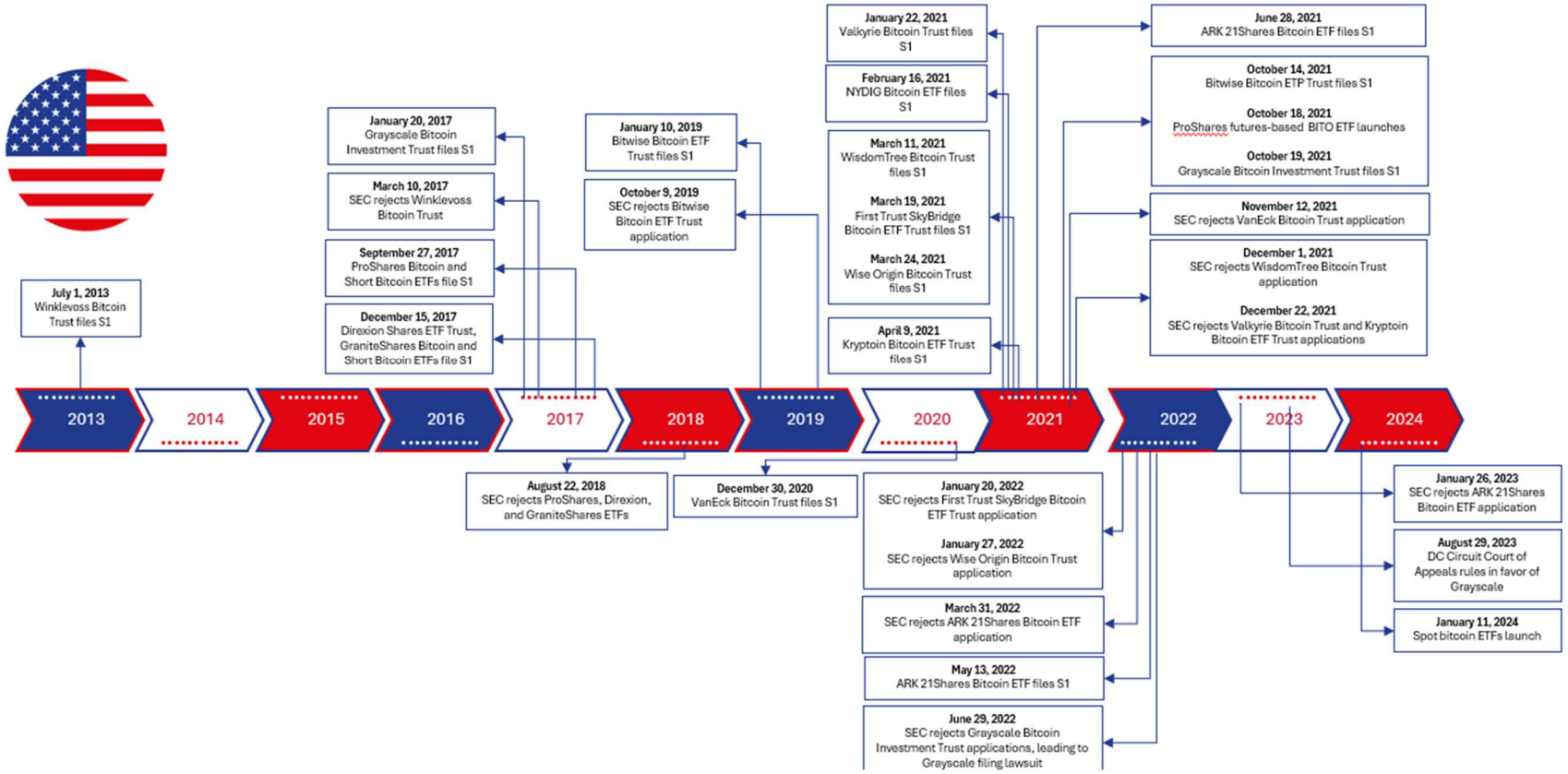
3.2 The U.S. experience

The struggle to list spot bitcoin ETFs in the U.S. lasted 10 years. The Winklevoss Bitcoin Trust filed the first application for a spot bitcoin ETF with the SEC in July 2013 under the COIN ticker. Almost four years later, in March 2017, the SEC rejected the application, citing, among other things, that the underlying commodity (bitcoin) market was susceptible to fraud and manipulation, due in part to it not being regulated like U.S. securities and commodity futures exchanges. Figure 1 summarizes the bitcoin application and rejection milestones.

On January 29, 2017, Grayscale filed an S1 with the SEC to uplift the Grayscale Investment Trust ("Trust") to ETF status, thereby allowing simultaneous creations and redemptions. By way of background, the Trust was launched in September 2013 to provide accredited investors access to bitcoin as an asset class. In May 2015, the Trust became publicly traded as a closed-end fund under the ticker symbol GBTC, allowing all investors to invest in it in their brokerage accounts. The January 2017 application would allow simultaneous creations and redemptions. This practice allows authorized participants (APs) to arbitrage between the ETF market and the spot market throughout the day, keeping the fund's market price per share in line with its intraday intrinsic value. Without this arbitrage, the market price floats freely above and below the daily NAV of the fund. Grayscale withdrew their application after a few months because they "… believed the regulatory environment for digital assets had not advanced to the point where such a product could successfully be brought to market."[3]

[3] See Casey Wagner, Grayscale files to convert GBTC to ETF, Blockworks (April 5, 2021).

Figure 1: Milestones in the struggle to list spot bitcoin ETFs in the U.S.



Other interesting milestones in Figure 1 include ProShares' filing for two futures-based bitcoin ETFs, $1x$ and $-1x$ products, in September 2017. Both were rejected in August 2018. ProShares later re-applied with only its $1x$ futures-based bitcoin ETF and was approved. On October 18, 2021, ProShares' Bitcoin Strategy ETF (BITO) was launched. Being a fully collateralized futures position, its performance should mimic spot bitcoin if there is active arbitrage between the spot bitcoin and bitcoin futures markets.

The SEC's decision to approve futures-based bitcoin ETFs while steadfastly refusing spot bitcoin ETFs was inherently contradictory. Where the SEC had denied spot bitcoin ETF applications because bitcoin was susceptible to fraud and manipulation in unregulated markets, they approved the futures-based ETF because the underlying asset is the CME's bitcoin futures—traded in a regulated market. The inherent contradiction is, of course, that the bitcoin futures are written on a spot bitcoin index that is based on prices of bitcoin that are susceptible to fraud and manipulation in unregulated markets.

On October 19, 2021, the day after BITO was launched, Grayscale announced that NYSE Arca had once again filed with the SEC to convert its bitcoin trust into an ETF. After the full statutory review period, the application was denied. On June 29, 2022, the same day of the SEC's denial, Grayscale filed a lawsuit in the DC Circuit Court of Appeals in response to the SEC's denial. In August 2023, the DC Circuit Court unanimously ruled in favor of Grayscale, vacating the SEC's denial. In its decision, the DC Circuit Court of Appeals highlighted the "obvious financial and mathematical relationship between the spot [bitcoin] and [bitcoin] futures markets", citing a comment letter by Whaley (2022). In the ruling, Judge Neomi Rao said that the denial was "arbitrary and capricious" because the regulator had not explained its rationale. On October 13, 2023, Bloomberg reported that the SEC would not ask a federal appeals court to reconsider its decision. On January 11,

2024, GBTC was uplisted as an ETF, and nine new spot bitcoin ETFs were launched.

3.3 Contrasting struggles in different venues

Spot bitcoin ETF's listing struggles were not unique to the U.S. We review the experiences in Canada, Australia, and Europe to place matters in context. Who are the relevant regulatory authorities, and what are their goals? What was the spot bitcoin application/application process in each regulatory authority and was it as slow as the SEC?

Canada

The Canadian regulatory approach differs from that of the U.S. In the U.S., the issuer and listing exchange must prove to the SEC that the ETF is consistent with the Securities Exchange Act of 1934 (e.g., supports investor protection, fair, orderly, and efficient markets, and is not susceptible to fraud and manipulation). In Canada, it is flipped. The Ontario Securities Commission (OSC) must show that the ETF does not follow its regulations.[4]

The Canadian approach is unusual. Given that the OSC's goals are to "protect investors from unfair, improper, or fraudulent practices" and "foster fair, efficient, and competitive capital markets and confidence in them," regulators should take the initiative and place the burden of proof on the issuer (not the regulator). At the same time, a prolonged approval period stifles financial innovation, leading to lost market opportunities and sub-optimally designed products.[5]

At times, the OSC's approach to fostering financial innovation has been progressive. Consider the development of stock index ETFs in the late 80s and early 90s. Ever since the launch of S&P 500 stock index futures in April 1982, U.S. and Canadian innovators had been trying to design stock index portfolio

[4] See OSC (2019, page 4, paragraphs 26 and 27).
[5] Section 4 contains a discussion of the pitfalls of futures-based ETFs.

securities. The development was accelerated by the Stock Market Crash of 1987, when stock index futures and stock markets became delinked by trading failures in the stock market. In February 1988, the SEC released a report called "The October 1987 Market Break" in which they noted that a market basket of stocks could have potentially minimized or avoided the damage of the 1987 crash.

In 1989, the American Stock Exchange (AMEX) and Philadelphia Stock Exchange began trading Index Participation Shares (IPS), a proxy for the S&P 500. Despite significant market interest, the Chicago Mercantile Exchange (CME) and the Commodity Futures Trading Commission (CFTC) filed a lawsuit claiming that IPS were futures contracts. A federal court in Chicago agreed and ruled that they could only be traded on futures exchanges. IPS was withdrawn from the marketplace.[6]

All the while, the Toronto Stock Exchange (TSE) went about designing a stock index product that mimicked the futures market concept of "warehouse receipts." The receipts guaranteed the quantity of each of the individual names of the underlying index stocks. On March 9, 1990, the TSE launched the Toronto-35 Index Participation Fund (TIPs) ETF to track the TSE-35. A few years later, the TSE used the same structure to launch the Hundred Index Participation Fund (HIPs) ETF to track the TSE-100.[7] Both products quickly became actively traded, attracting both Canadian and international investors.

The success of TIPs did not go unnoticed in the U.S., where equivalent products were under development. Led by Nathan Most, Senior Vice President for Product Development at the AMEX, a team at AMEX designed a security that met the SEC's 1988 report goals. After protracted discussions with different banks and fund companies, AMEX partnered with State Street to develop a unit investment

[6] Gastineau (2010, pp. 25-34) has a brief history of all ETFs.
[7] TIPs eventually merged with HIPs to form the S&P/TSE Index Participation Fund (XIU) on March 7, 2000. XIU is benchmarked to the iShares S&P/TSX 60 Index.

trust. With the trust infrastructure in place, AMEX began the process of seeking SEC regulatory approval. In January 1993, Standard and Poor's Depository Receipts (SPDR) were launched. SPDR's were later renamed the SPDR S&P 500 ETF (SPY). SPY is currently the largest and most actively traded ETF in the world.

3iQ was the pioneer in digital spot bitcoin investment in Canada. In late 2016, The Bitcoin Fund (a closed-end fund) and 3iQ had a series of meetings and correspondence with the OSC's Investment Funds & Structured Products (IFSP) branch. The IFSP Staff reviewed the preliminary prospectus provided by the filers and provided comments. Ultimately the IFSP Staff advised The Bitcoin Fund and 3iQ that the application would be refused. The applicants requested a written explanation about the refusal. On February 15, 2019, the OSC Director issued a formal denial citing

> "… concerns about bitcoin's liquidity and the integrity of the bitcoin markets, and concerns about The Bitcoin Fund's ability to value and safeguard its bitcoin and file audited financial statements."[8]

The Bitcoin Fund and 3iQ continued its pursuit in the next months. It applied for a hearing and review of the OSC Director's decision. The application was granted, and a "special panel" was appointed. It met in June and July 2019 to evaluate the merits of the arguments. On October 29, 2019, the panel concluded that the concerns did not call for denial. They instructed the OSC Director to issue a receipt of the prospectus. Excerpts from the panel's report overview include:

> "Bitcoin is a novel asset in an emerging and evolving market." "Some novel asset classes and securities products fail. They become tulip bulbs or dot.com's. Others succeed and become gold or the next great technology. Securities regulators are not mandated to try to pick winners and losers.".[9]

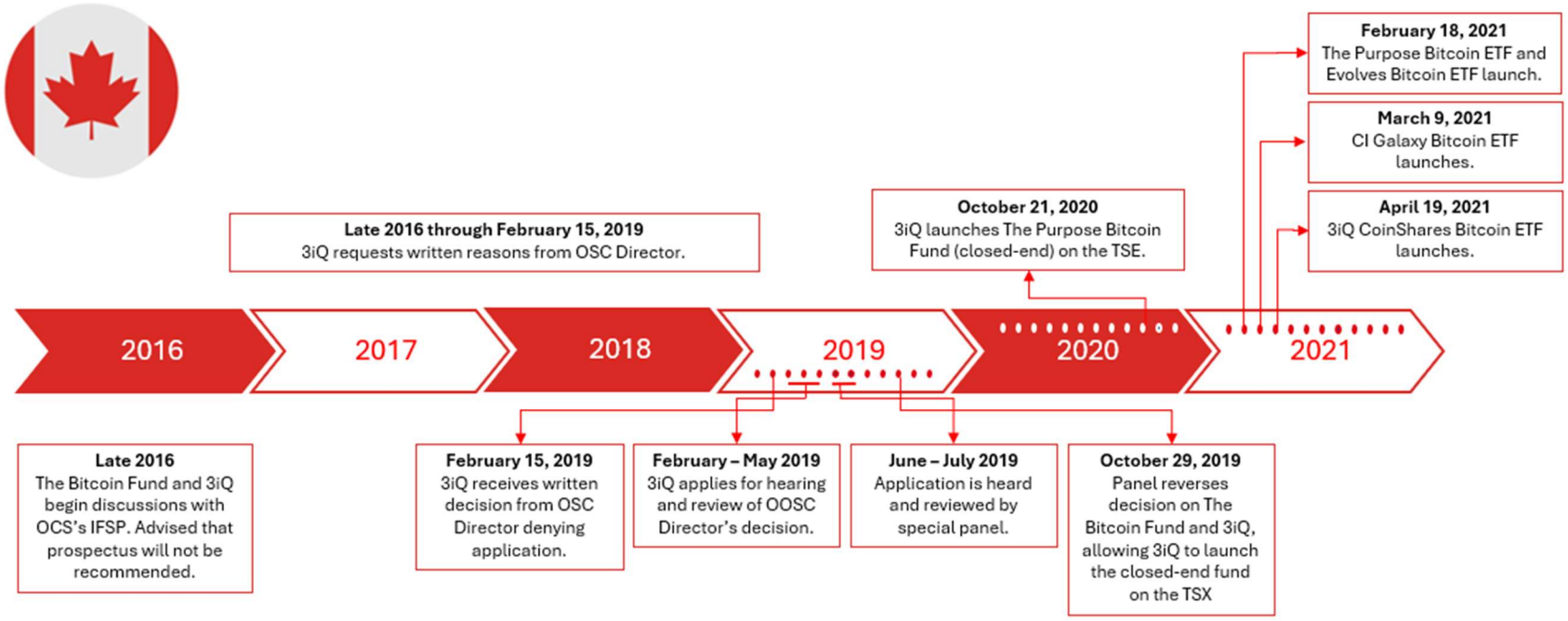
[8] See OSC (2019, p.2, #10).
[9] See OSC (2019, p.1, #6 and #7).

On October 21, 2020, 3iQ launched The Bitcoin Fund on the TSE. Though not an ETF, it paved the way for the spot bitcoin ETF (an open-end fund) listings that quickly followed. Figure 2 highlights the milestones.

The first spot bitcoin ETF in Canada was The Purpose Bitcoin ETF (BTCC), launched on February 18, 2021. Purpose Investments pre-filed its prospectus for its ETF in September 2020, allowing the OSC to provide confidential feedback on the product and hasten the review process without publicly divulging the contents of the potential prospectus. The formal filing was on February 10, 2021, and the product was launched eight days later. The Evolve Bitcoin ETF was also launched on February 18, 2021, three weeks after filing its preliminary prospectus. The CI Galaxy Bitcoin ETF began trading on March 9, 2021, and the 3iQ CoinShares Bitcoin ETF launched on April 19, 2021.

From the first discussions between 3iQ and the OSC in late 2016, the Canadian "struggle" took three years. Given that spot bitcoin application was for an unprecedented new asset class product rather than a copy of a past design, the OSC was initially reluctant to approve spot bitcoin ETFs. After 3iQ insisted upon a more careful and formal review of the merits of the denial, the OSC conceded that it was wrong, and that the denial was rescinded. The OSC's proactive support thereafter allowed Canada to launch spot bitcoin ETFs in 2021, three years before the U.S., even though the U.S. application process started three years earlier.

Figure 2: Milestones in the struggle to list spot bitcoin ETFs in Canada.



Australia

The Australian Securities and Investment Commission's (ASIC's) goals include keeping, helping, and improving "… the performance of the financial system…" and promoting "… confident and informed participation by investors and consumers in the financial system." Historically, the ASIC had been proactive in setting rules and providing guidance. For example, while the SEC and OSC approved listings of levered and inverse (L&I) ETFs as early as 2006,[10] the ASIC carefully evaluated the merits of these products in the context of investor protection. They decided that L&I ETFs were too complicated for retail investors to understand. The daily reset of the gearing ratio causes multi-day returns to deviate unpredictably and often substantially from expected returns. Years later, the ASIC Report 282 (2012, p.15) reaffirmed their policy. L&I ETFs are not allowed in Australia. From an investor protection standpoint, their decision was smart. Actual investor experience with L&I ETFs in the U.S. and Canada has been, in many instances, catastrophic.[11]

A similarly protective stance was taken by the ASIC (2021), when it released guidance on how crypto exchange-traded products could enter the market. The ASIC had consulted with public experts, receiving 32 responses on best practices for exposing investors to bitcoin. Their guidance outlined key characteristics such as admission and monitoring standards, custody of crypto assets, pricing methodologies, and disclosure and risk management frameworks for issuers to meet regulatory obligations.

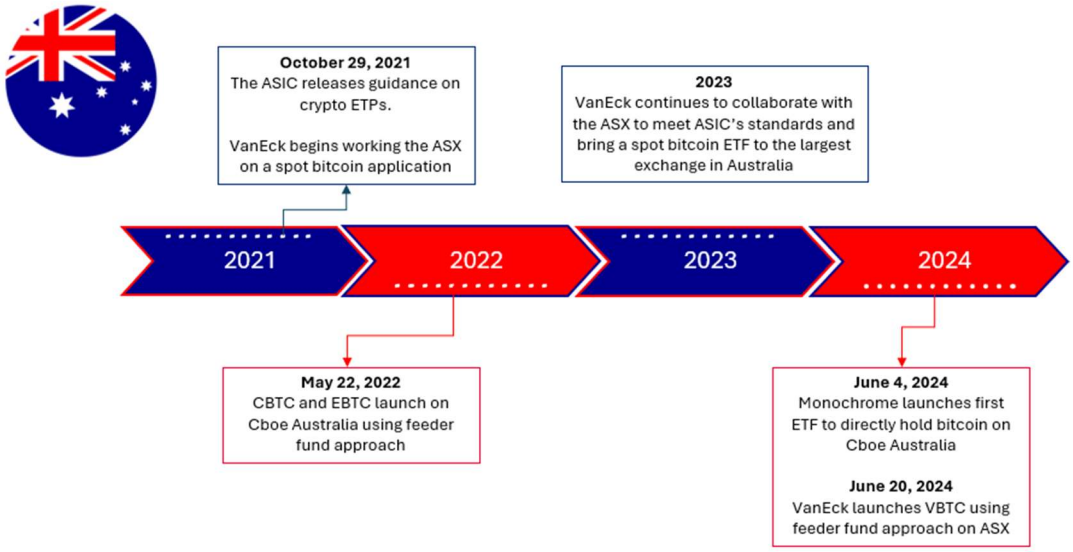
Immediately after the publication of the ASIC framework, VanEck started working with the Australian Securities Exchange (ASX) to develop a filing for a spot bitcoin ETF. Figure 3 shows the Australian milestones. On May 22, 2022, the ETFs 21Shares Bitcoin

[10] ProShares was the first mover in the U.S., launching -1*x* and 2*x* ETFs on the S&P 500, Dow, Nasdaq 100, and Mid-cap 400 on 20060619. They added -2*x* ETFs on the same benchmarks less than one month later. Horizons was the first mover in Canada, launching -2*x* and 2*x* ETFs on the S&P/TSX 60 on 20070108. Horizons added -2*x* and 2*x* ETFs on a Canadian gold miners futures index on 20070615.

[11] The most noteworthy of the levered and inverse fund fiascos was Volmageddon on February 5, 2018, when the benchmark for three inverse ETPs on the S&P 500 VIX Short Term Futures Index fell by over 96%. Shortly thereafter, Credit Suisse AG (XIV) and Horizons (HVI) announced that trading its products would end. Rather than delisting, ProShares (SVXY) reduced its leverage ratio from -1*x* to 0.5*x*.

ETF (EBTC) and the Cosmos Purpose Bitcoin Access ETF (CBTC) were listed on Cboe Australia. Both funds used a "feeder fund" approach, bypassing the ASIC's crypto ETP rules by "holding shares, not bitcoin." Before its delisting in November 2022, CBTC's spot exposure was based on holdings of the Canadian Purpose Bitcoin ETF, the largest bitcoin ETF in Canada. EBTC's spot exposure is via the Global X 21Shares Wholesale Bitcoin Trust, defined as an "unregistered managed investment scheme."[12]

Figure 3: Milestones in the struggle to list spot bitcoin ETFs in Australia.



After collaborating with the ASX to meet ASIC's standards, VanEck re-emerged in February 2024 with a spot bitcoin ETF application. Four months later, it was launched on the ASX under the ticker VBTC. This fund allowed investors to access bitcoin via traditional brokerage accounts, simplifying the investment process and fostering competition among fund managers. Despite the developmental progress, however, VBTC fell short of holding actual spot bitcoin. It was a feeder fund for the U.S.-traded VanEck Bitcoin Trust ETF (HODL). VBTC requires its shareholders to pay HODL

[12] See VanEck (2024).

management fees as well as their own and exposes them to AUD/USD exchange rate risk. Monochrome Asset Management launched the first Australian ETF (IBTC) to hold bitcoin directly under an Australian Financial Services License. IBTC was listed on Cboe Australia on June 4, 2024, and is designed to track the price of bitcoin in AUD.

Overall, the process of bringing spot bitcoin ETFs to the Australian stock market was efficient and prompt. From the release of the ASIC's cryptocurrency document until the launch of an ETF on actual spot bitcoin in AUD was a remarkably short three years.

Europe

The spot bitcoin ETF story in Europe is a classic work-around. The Undertakings for Collective Investment in Transferable Securities (UCITS) provides the European Union's (E.U.'s) regulatory framework for investor protection. Funds compliant with UCITS are the 'gold standard' and can be marketed and sold cross-border. To be a UCITS-compliant, an ETF must diversify. No single holding can make up more than 10% of a fund's net asset value (NAV). In short, UCITS-compliant spot bitcoin ETFs cannot currently exist.

What has appeared, instead, are spot bitcoin ETPs and notes ETNs. The first was the 21Shares Bitcoin ETP (ABTC), listed in February 2019. Like other such structured products, the collateral (i.e., spot bitcoin) is held by a custodian. Like other ETPs and ETNs, unitholders inherit the credit risk of the issuer. These ETPs and ETNs trade on stock exchanges such as Euronext, the London Stock Exchange, and the SIX Swiss Exchange. The current market value of these funds is about five billion USD.

While debt-based ETPs have become the norm in the E.U., other fund structures have appeared. Jacobi Asset Management (JAM) proposed the Jacobi FT Wilshire Bitcoin ETF (BCOIN) in 2021. JAM, based in London, had its "ETF" approved by the Guernsey Financial Services Commission (GFSC) in October 2021. Guernsey, a self-governing British Crown dependency, allowed the instrument to structure itself as an alternative investment fund (AIF), restricting access to professional U.K. and Netherlands investors. BCOIN launched on August 15, 2023, and requires a minimum investment of $100,000.

Fidelity Digital Assets is custodian and holds the spot bitcoin. The product is not UCITS-compliant and hence does not enjoy UCITS benefits and protections.

In summary, the spot bitcoin ETFs are simply not allowed in Europe. The UCITS's diversification rule excludes them from consideration. Spot bitcoin-backed ETPs and ETNs have appeared as early as 2019, but they are generally not regarded as close substitutes. Since they are not UCITS-compliant, they are viewed as a weaker member of the spot bitcoin family. Unless UCITS diversification requirements change to accommodate widely available ETFs, the current European environment will likely persist.

4. Evaluating economically exchange-traded bitcoin investments

The motivation for developing exchange-traded spot bitcoin ETFs is clear. The return properties of bitcoin can improve investor long-term financial planning and having access to spot bitcoin traded in the familiar, safe, liquid, and low-cost U.S. securities markets is ideal. From the bitcoin investment perspective, the decision to invest is done in the usual way – by maximizing expected portfolio return for a given risk tolerance.[13] The difficulty is parameter estimation. What are bitcoins' expected return, expected volatility, and expected pairwise correlations given its relatively brief history? It is unlikely that anyone would dispute the assumption that the expected pairwise correlation of bitcoin returns with other asset class returns will be around 0%. Years of empirical evidence has confirmed it.[14] Similarly, it is unlikely that anyone would dispute

[13]"Standard portfolio allocation mechanics" the framework developed by Markowitz (1952). It remains an indispensable investment tool more than 70 years later.

[14] The empirical (historical) evidence on this issue over the past decade is quite compelling over the last decade. Briere *et al* (2015) show that the pairwise return correlations of bitcoin with the traditional asset classes are not statistically significant different from zero using weekly data from *Bitcoincharts* for the period July 2010 through December 2013. Using a more recent sample of daily data for the period August 2011 through June 2018 from *Datastream*, Smales (2019) finds pairwise correlations of bitcoin of 0.00 for gold and 10-year U.S. Treasury notes and 0.02 with the S&P 500 and Nasdaq 100. More interestingly and importantly, perhaps, Hougan and Lamont (2021) use 90-day returns to compute rolling pairwise correlations and volatilities during the period July 2010 through September 2020 and show that the correlation estimates are increasing, and volatilities are falling. What this implies, among other things, is that long-term investors may want to review the parameter assumptions of the portfolio allocations more frequently. Liu and Tsyvinski (2021) document the financial characteristics of major cryptocurrencies like

the assumption that the expected future volatility of bitcoin will be about three or four times higher than stocks (i.e., traditionally the asset class with the highest return volatility), and many times higher than a typical long-term investor will tolerate. Although bitcoin's return may be independent of other asset classes, it still contributes to portfolio volatility directly when few asset classes are considered. What is highly unlikely, however, is a consensus estimate of bitcoin's expected return. Historical "bubble-like" returns offer little guidance. One set of market prognosticators say the sky is the limit, while another says the bubble will burst. In the middle is finance theory, which says that, since bitcoin investment involves cash outlay but no market risk(s), its expected return is the risk-free rate.

This section does not offer advice on using bitcoin as a potential asset class in an investor's long-term investment allocation strategy. Instead, it evaluates which of the U.S. exchange-traded bitcoin investment tools is best if a bitcoin allocation is being considered. We start by considering the most recently launched products – spot bitcoin ETFs. Before their launch, the only direct access to spot bitcoin for most investment professionals was through trusts. Unfortunately, trusts like Grayscale' GBTC are closed-end funds and typically are at a premium or a discount to net asset value (NAV). On January 11, 2024, that ended. Nine new spot bitcoin ETFs as well as the GBTC conversion became actively traded and market prices per share became aligned with NAV because of the creation/redemption process. We then consider the bitcoin futures market in the U.S and its idiosyncrasies. In theory, an investment in cash and bitcoin futures should replicate the spot bitcoin return/risk performance. Over its history, it does not come close. We will explain why. The third and final exchange-traded alternative is futures-based bitcoin ETFs. We show that they are nothing more than the fully collateralized bitcoin futures position discussed above. The reduced return performance of these products is driven by the expense ratio of the ETF and the increased risk is driven by the

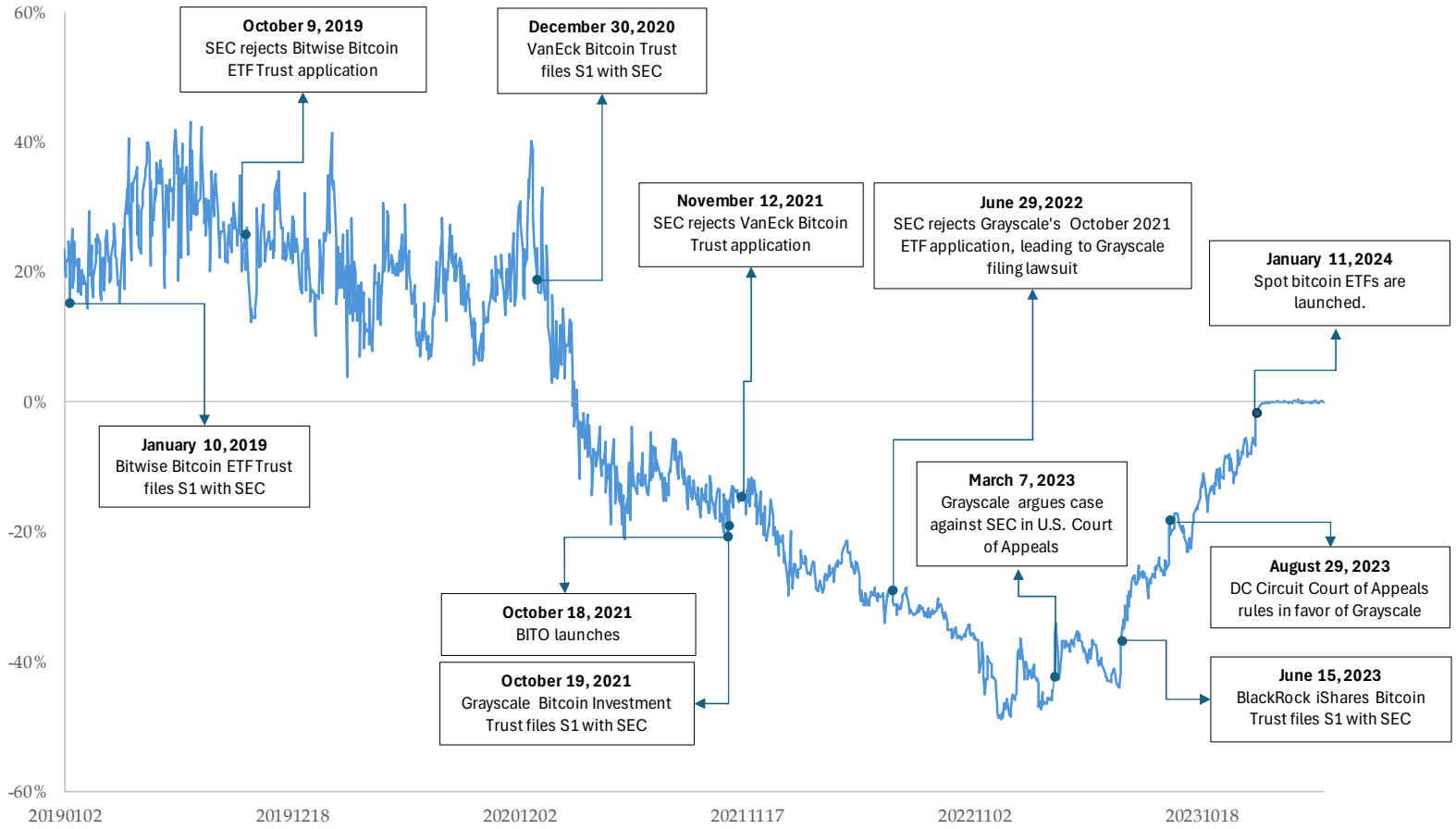
bitcoin using daily data for the period January 2011 through December 2018. Their results are consistent with earlier work. Bitcoin has no exposure to tradition asset classes and is highly volatile. They also find cryptocurrency returns have a common market risk factor and have momentum.

futures basis and the fund's benchmark replication strategy. The section ends with a summary of the haphazard way exchange-traded bitcoin markets were developed in the U.S.

4.1 The spot bitcoin ETF explosion

The backdrop for the explosion can be seen in the daily behavior of GBTC's percentage premium/discount (i.e., market price (MP) per share compared to net asset value (NAV) per share) before and after January 11, 2024. When GBTC was traded in the OTC markets as a publicly traded private placement, it behaved like a closed-end fund. Without the arbitrage created by the creation/redemption mechanism arbitrage, the MP fluctuated around the NAV due. A premium persisted in the early months of Figure 4, peaking at 43% on July 15, 2019. It later turned to a discount, hitting an all-time low discount of 49% on December 13, 2022. On March 7, 2023, when Grayscale argued its case against the SEC in the United States Court of Appeals, the discount was 36%. On June 15, 2023, BlackRock filed their S1 with the SEC and the stock price popped upward. By August 29, 2023, when the Court ruled in Grayscale's favor, the discount had narrowed to 18%. When news broke that the SEC would not appeal the Court's decision, the discount further narrowed to 16%. On the launch date of January 11, 2024, the discount reduced to 1.6%. Since the launch, the average daily premium/discount has been –0.07%, as shown by the flatlining on the right-hand side of the figure.

Figure 4: Premium/discount (%) of Grayscale Bitcoin Trust (GBTC) in the years preceding its conversion to an ETF structure on January 11, 2024. The premium/discount is defined as MP/NAV-1, where MP is market price per share and NAV is net asset value per share.



An end to indecision

The unchallenged decision by the United States Court of Appeals put an end to Grayscale's protracted battle with the SEC. It was a huge victory. The product that should have been there in the beginning was finally approved. Over the ensuing months, the details of the spot bitcoin ETF launches were worked out. Nine issuers free rode on Grayscale efforts. The competing products are listed in Table 2. The struggle for market share was so intense after the victory that the competition among issuers on expense ratios began before the product launch.[15] For issuers, the competition will be expensive but short-lived. A few ETFs will develop deep and liquid markets; others are likely to delist. For investors, the competition has been a windfall. Some funds are waiving the entire expense ratio! The launch date, January 11, 2024, will undoubtedly live in infamy in the historical records of the ETF industry. Never have multiple ETFs on the same underlying asset been launched simultaneously.[16]

The menu of spot bitcoin ETFs

Table 2 lists the spot bitcoin ETFs launched on January 11, 2024. Futures-based BITO is also included for benchmarking expense ratios. The expense ratios for the nine newly launched funds are relatively low. Since the spot bitcoin ETFs are perfect substitutes for one another, competition for market share is at work. Indeed, three ETFs were temporarily waiving fees. At the time of the launch, Grayscale reduced its management from a hefty 2% to a slightly less hefty 1.5%. It seems Grayscale's strategy was to rely on the loyalty of investors who have been with the GBTC Trust for years. For these investors to divest their holdings in GBTC in favor of one of the low-cost providers would involve the payment of significant capital gains tax. The expense ratio of BITO, a futures-based

[15] See "Asset managers start fees war over potential spot bitcoin ETFs," *Financial Times* (January 8, 2024).
[16] It is interesting to note that Vanguard, the second largest ETF provider, chose not to offer a spot bitcoin ETF. See "Vanguard has no plans to join spot bitcoin ETF fray," *Financial Times* (January 17, 2024). The company is quoted as saying "Our perspective is that these products do not align with our offer focused on asset classes such as equities, bonds and cash, which Vanguard views as the building blocks of a well-balanced, long-term investment portfolio."

ETF, is also well above the newly established norm. We will discuss this matter further shortly.

Table 2: Selected attributes of spot bitcoin ETFs launched on January 11, 2024. BITO, a futures-based ETF is also included.

		Issuer information*			
Ticker	Name	Snapshot date	Inception date	Expense ratio	Benchmark index**
ARKB	ARK 21Shares Bitcoin ETF	20240229	20240110	0.21%	BRRNY
BITB	Bitwise Bitcoin ETF	20240331	20240110	0.20%	BRRNY
BRRR	Valkyrie Bitcoin Fund	20240424	20240110	0.25%	BRRNY
BTCO	Invesco Galaxy Bitcoin ETF	20240229	20240111	0.00%	LPRR
BTCW	WisdomTree Bitcoin Fund	20240425	20240111	0.00%	BRRNY
EZBC	Franklin Bitcoin ETF	20240331	20240111	0.19%	BRRNY
FBTC	Fidelity Wise Origin Bitcoin Fund	20240425	20240111	0.00%	FBRR
HODL	VanEck Bitcoin Trust	20240331	20240111	0.25%	BRRNY
IBIT	iShares Bitcoin Trust Registered	20240425	20240111	0.25%	BRRNY
GBTC	Grayscale Bitcoin Trust	20240328	20240111	1.50%	XBX
BITO	ProShares Bitcoin Strategy ETF	20240331	20211019	0.95%	None

*Source: Compiled from most recent information on issuer websites and ETFdb.com.

** Benchmark index key:

BRRNY	CME CF Bitcoin Reference Rate - New York Variant
LPRR	Lukka Prime Reference Rate
FBRR	Fidelity Bitcoin Reference Rate
XBX	CoinDesk Bitcoin Price Index

Most funds are using the CME CF Bitcoin Reference Rate – New York variant (BRRNY) as their benchmark index. GBTC uses the CoinDesk Bitcoin Price Index (XBX), which has the longest data history. Other issuers like Fidelity created their own benchmark. No matter, all the benchmark returns are nearly perfectly correlated and have essentially the same return/risk properties. The futures-based BITO reports no

benchmark index, preferring only to say "ProShares Bitcoin Strategy ETF seeks results, before fees and expenses, which correspond to the performance of bitcoin."[17]

Performances since start

The performance evaluation period is the 97-trading day period from 20240111 until 20240531, when this paper was written. Performance statistics are reported in Table 3, and supplemental results are reported in Appendix 1. As of 20240531, IBIT was the largest spot bitcoin ETF with AUM of $19.7B. Grayscale was a close second at $19.3B. While Grayscale's $AUM is impressive in terms of the others, its level is $9.3B lower than it was on the pre-launch date, 20240110.

The $TVOL column is the average daily dollar volume of shares traded in millions of USD across the period. IBIT is the most active, followed by GBTC and FBTC. The relative bid/ask spread column is the volume-weighted average of the bid/ask quotes appearing immediately preceding a trade during regular trading hours (RTH) in the U.S. on 20240531. IBIT and FBTC are lowest at 0.072%. Taken altogether, the information on $AUM, $TVOL, and relative spreads for BlackRock's IBIT and Fidelity's FBTC indicates that their products are, and will continue to be, dominant. The other ETFs are languishing.

Another interesting feature of Table 3 is the average holding period in days. The average holding period (AHP) equals $AUM/$TVOL (i.e., the inverse of the turnover ratio). The lowest AHPs are BTCW and BITO. BITO is interesting in the sense that it has not suffered a decline in $AUM since the launch of the spot ETFs. It has about $2.1B in AUM and has an AHP of 4.5 days. BITO appears to be used for speculation. If traders are holding BITO for only a few days (presumably in the hope of a large price movement), a few pennies a day for management fees hardly matters. What matters is market liquidity, and, as Table 3 shows, BITO'S relative bid/ask spread is small. At the other end of the spectrum, BRRR and EZBC are being held for 63 days and 37 days, respectively. These

[17] See BITO: ProShares Bitcoin Strategy ETF (March 31, 2024).

ETFs appear to be used as investments. As long-term investors become more comfortable with considering spot bitcoin as an asset class, we can expect AHPs to become higher.

Table 3: Performances of spot bitcoin ETFs from 20240111 through 20240531 (97 trading days). The performances of futures-based BITO ETF and spot-based BRRNY are also included for comparison.

		Levels on 202405121				Realized from 20240111 to 20240531		
		In millions		Holding period	Relative bid/ask		Annualized	Return/
Ticker	Name	$AUM	$TVOL	in days	spread	Return	volatility	risk ratio
IBIT	iShares Bitcoin Trust Registered	19,674	1,214.1	16.2	0.072%	44.6%	57.0%	0.78
GBTC	Grayscale Bitcoin Trust	19,261	762.3	25.3	0.178%	44.3%	56.9%	0.78
FBTC	Fidelity Wise Origin Bitcoin Fund	11,082	534.9	20.7	0.072%	44.6%	57.2%	0.78
ARKB	ARK 21Shares Bitcoin ETF	3,183	152.2	20.9	0.119%	44.8%	56.8%	0.79
BITB	Bitwise Bitcoin ETF	2,482	88.3	28.1	0.088%	45.4%	56.8%	0.80
HODL	VanEck Bitcoin Trust	674	26.1	25.8	0.183%	44.5%	56.9%	0.78
BRRR	Valkyrie Bitcoin Fund	579	9.2	62.7	0.238%	44.2%	56.9%	0.78
BTCO	Invesco Galaxy Bitcoin ETF	493	31.3	15.7	0.195%	44.8%	57.1%	0.78
EZBC	Franklin Bitcoin ETF	415	11.1	37.2	0.788%	45.3%	56.8%	0.80
BTCW	WisdomTree Bitcoin Fund	86	19.9	4.3	0.209%	47.7%	56.5%	0.84
BITO	ProShares Bitcoin Strategy ETF	2,115	473.4	4.5	0.081%	41.8%	57.5%	0.73
BRRNY	CME CF Bitcoin Reference Rate - NY					44.6%	53.8%	0.83

The final columns review return performance. The realized return column is the holding period return over the 97-trading day period, and volatility is the annualized standard deviation of the return. Finally, the "Return/risk" column is the realized return divided by volatility. Return/risk is the same for the top three spot bitcoin ETFs. Their returns and volatilities are virtually the same. Appendix 1 also shows their pairwise correlations. All spot bitcoin ETFs have near perfect correlation with one another. Taken together, all these summary statistics show the spot bitcoin ETFs are near perfect substitutes for one another.

BITO is a laggard in terms of investment performance. Its return/risk ratio is much lower than that of spot bitcoin offerings. We will explain its poor performance shortly. The spot bitcoin index, BRRNY, has a high return/risk ratio of 0.83. While its return is about the same as that of spot bitcoin offerings, its volatility is lower. This is likely driven by the fact that BRRNY is a volume-weighted average price (VWAP) across multiple

exchanges over the last hour of the trading day. The index level is "smoothed" by the diversification across exchange prices and through time.

Assets under management

The competition among the ten spot-bitcoin and one futures-based ETFs since the product launch has been intense. Table 4 provides snapshots of where bitcoin funds stood on 20240110 and 20240531. On the day before the spot bitcoin launch, the $AUM of the two funds of relevance was $30.8B, with Grayscale holding 92.9% of the market and BITO holding 7.1%. Ninety-seven trading days later, total AUM grew to $60.0B – an increase of 95.1%). IBIT finished first and now holds 32.8% of the $AUM, GBTC finished second with 32.1%, and FBTC finished third with 18.5%. The remaining spot ETFs accounted for 13.2% of the total.

Over the 97-day period, GBTC experienced a significant loss, amounting to 32.6% of its assets under management. Initially, one might assume this loss was entirely due to GBTC's decision to keep an expense ratio of 150 bps compared to IBIT's 25 bps. This assumption is wrong. A major factor contributing to the loss was the billions of dollars of GBTC shares tied up in bankruptcy estates before the uplisting. These shares were sold shortly after GBTC's uplisting, not because of the management fees, but because the market price of GBTC had risen from its pre-uplisting deep discount to fair value allowing the bankruptcy estates to repay its creditors at fair value. (Recall Figure 4.) Ultimately, time will resolve where GBTC market share will fall in relation to the other market leaders, IBIT and FBTC. At current AUM levels, GBTC's annual revenue is about $19,261M times 0.150 or $288.9M compared with IBIT's annual revenue of $49.2M.

Interestingly, BITO managed to keep 96.7% of its $AUM despite its 0.95% expense ratio. To some extent, this is not surprising. BITO had the first-mover advantage and is largely used for short-term speculative purposes. Recall that, in Table 3, we reported that the average holding period for a BITO shareholder is only 4.5 days. Although its expense ratio is high compared to the others, expense ratios are only important for buy-and-hold investors. Day traders care mostly about market liquidity, and BITO is highly active.

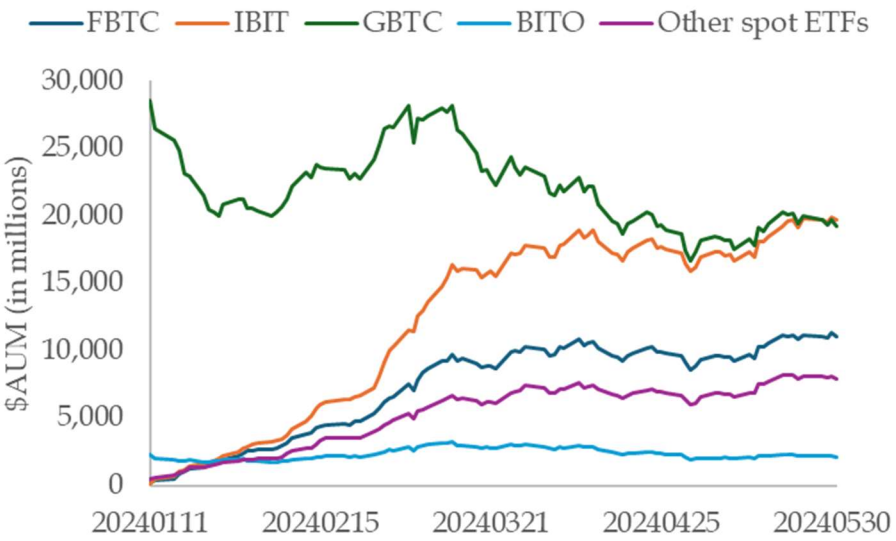
Table 4: Assets under management in millions of U.S. dollars for the three largest spot bitcoin ETFs (i.e., IBIT, GBTC and FBTC) and the largest futures-based ETF (i.e., BITO) on January 10, 2024, and May 31, 2024.

	20240110		20240531		Percent
Ticker	$AUM	Percent	$AUM	Percent	growth
IBIT			19,674	32.8%	
GBTC	28,581	92.9%	19,261	32.1%	-32.6%
FBTC			11,082	18.5%	
Other spot ETFS			7,912	13.2%	
BITO	2,187	7.1%	2,115	3.5%	-3.3%
Total	30,768		60,043		95.1%

Finally, Figure 5 shows the evolution of the $AUM of the bitcoin ETFs since 20240111. The decline in $AUM for GBTC is not unexpected. But the growth rates in $AUM of IBIT and FBTC are remarkable. It is curious that IBIT won the day with its effective net expense ratio of 12 bps,[18] while FBTC's was 0 bps. One possible explanation is that BlackRock is the largest ETF provider in the U.S. and has a well-oiled marketing machine. Another is that the FBTC waiver expires on 20240731, at which time it will match IBIT at 25 bps.

[18] Initially IBIT's net expense ratio was 0.12% until IBIT reached $5B is AUM. As of 20240531, the fee waiver was removed. The fee expense ratio is currently 0.25%.

Figure 5: Spot bitcoin ETF assets under management in millions of U.S. dollars from January 11, 2024, through May 31, 2024. Futures-based BITO is also included.



4.2 The inherent contradiction

At this point, we take a step back in time. Spot bitcoin ETF applications began in 2013. All were refused by the SEC on the grounds that the underlying asset was susceptible to fraud and manipulation and traded on unregulated exchanges. Viewed in this light, it is curious that the CME Group received permission to list bitcoin futures contracts in December 2017 when its bitcoin futures are settled to an index that has the same properties as those being used to reject the spot bitcoin ETFs.

By way of contract description, the contract size is five bitcoins. On 20240531, the price of the June 2024 futures was $68,035. The value of a single June 2024 futures was, therefore, $340,175, no small amount. Initial margin requirements are 40.7% for speculators and 37.0% for hedgers, amounts well beyond other commodity contracts. This is clearly an institutional, not retail, market. The futures contract is cash-settled to the CME CF Bitcoin Reference Rate (BRR).[19] Trading ends at 4:00 PM London time on the

[19] BRR has become the standard bitcoin reference rate. Its construction is described in CF Benchmarks (2024). It is a weighted average of bitcoin prices from six cryptocurrency exchanges: Coinbase, Bitstamp,

last Friday of the contract month. If the date is not a London and U.S. trading date, trading ends on the prior London or U.S. business day. Listed contracts include (a) monthly contracts for six consecutive months, (b) quarterly contracts (Mar, Jun, Sep, Dec) for 4 additional quarters, and (c) a second Dec contract if only one is listed.

Perfect substitutes?

The valuation-by-replication principle says that, if two investments yield the same future outcome, they must have the same price today; otherwise, arbitrage opportunities arise. Consider an individual who wants to hold spot bitcoin at a future time T, with the cost known today. One way to achieve this is by buying a bitcoin futures contract now. At time T, the individual pays the futures price F and receives the spot bitcoin. Another way is to buy spot bitcoin at the current price B, finance the entire purchase at an interest rate r, and hold it until time T. During this period, storage costs also increase at rate s for holding the spot bitcoin. Thus, the two options should have the same total cost to prevent arbitrage opportunities. Thus, $Be^{(r+s)T} = Be^{cT}$ and

$$F = Be^{cT} \qquad \textbf{(1)}$$

where F and B are the bitcoin futures and spot prices, T is the time to futures contract expiration, and c is the "bitcoin carry rate."

"Implied" carry cost rate

The cost of carry relation can be applied in many ways. One practical application involves the implied carry rate. Since new market information changes the levels of the spot and futures prices from day to day, it becomes harder to figure out whether the character of the futures curve has changed. To circumvent this problem, we can invert (1) to isolate the carry rate, that is,

itBit, Kraken, Gemini, and LMAX Digital. See CF Benchmarks (2023). Its daily settlement occurs at 4:00PM London time. A U.S. settlement of this spot bitcoin index also occurs at 4:00PM ET and is available under the ticker symbol BRRNY. It is the benchmark index for many of the newly launched spot bitcoin ETFs.

$$c = \frac{\ln\left(F / B\right)}{T} \ . \qquad \textbf{(2)}$$

Non-carry markets

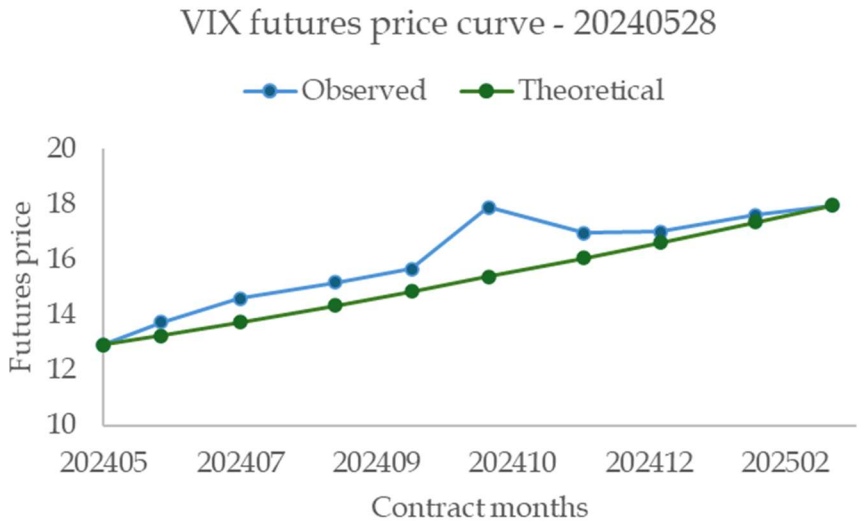
The cost of carry relation does not hold in markets with trading impediments that impede futures arbitrage. In the VIX futures markets, for example, the cost of carry relation does not hold because the spot VIX is too costly to trade. The spot VIX is a portfolio of hundreds of S&P 500 index options and must be rebalanced daily. It is impractical to buy and sell on an intraday basis. Arbitrage is impossible with no "anchor" (i.e., no tradable spot VIX). VIX futures prices are set from supply and demand at each contract maturity.

Any shape futures price curve may prevail. To illustrate, consider the VIX futures price curve on 20240528, displayed in Figure 6 below. The green line is the theoretical futures price curve based on the implied carry rate of the 202502 futures, 45.1%. The blue line holds the observed VIX spot and futures prices. Using the 202502 implied carry rate forces the theoretical curve to match the observed curve at the beginning of the series (i.e., spot VIX) and at the 202502 futures price (i.e., the most extended term futures contract traded on that day). Note that the observed futures price curve is above the theoretical curve over the entire range of contract months. The difference implies that the VIX futures market is in contango. The curve is also jagged. Each contract month has its own supply/demand conditions deciding its price.[20] The stories behind the supply/demand conditions cannot be fully known because finding the motives and quantities demanded by buyers and sellers is impossible. Sometimes general information can be inferred. For example, the elevated price of the 202410 futures (i.e., the expected stock market volatility

[20] Keynes (1930) was the first to argue this point and label the market conditions. When there are more short hedgers than long hedgers, futures prices will fall until speculators are satisfied with the risk premium and step up to absorb the imbalance. He called the result downward-sloping futures price curve "normal backwardation." By the same logic, when there are more long hedgers than short hedgers, the futures price curve will slope upward, a condition he called "contango." The abnormal blip of the 202410 VIX futures contract is attributable to buying pressure from individuals or individuals wanting to hedge the risk they perceive from the results of the November 2024 Presidential election.

for the 30 days beginning 20241016) reflects the market's anxiety surrounding the November 2024 election.

Figure 6: VIX futures price curve at the close on Tuesday, May 28, 2024. The spot VIX, as well as nine VIX futures contracts, are shown.



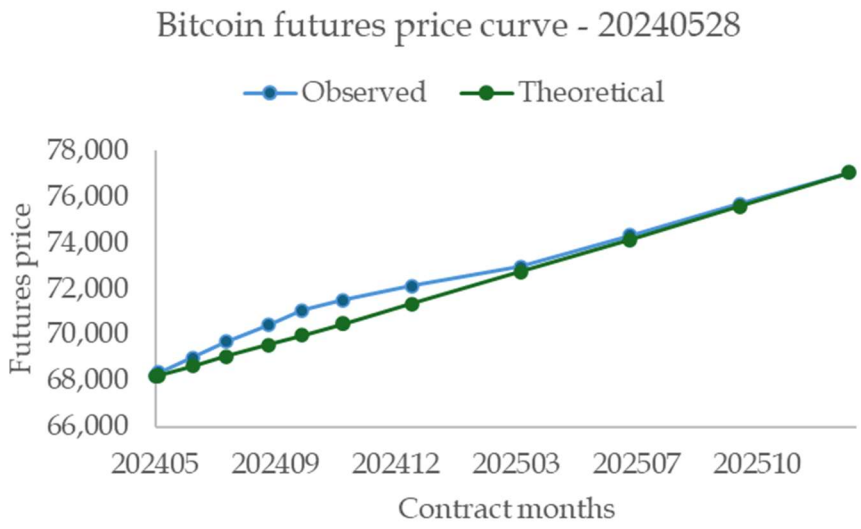
Many commodity futures markets are non-carry markets and have similar behaviors. Crude oil, natural gas, grains, and livestock come to mind. In each of these markets, futures pricing is decided by supply and demand at each of the different contract maturities.

Bitcoin futures market

Unlike the VIX futures (or other non-carry futures), the bitcoin futures have an "anchor." The market for spot bitcoin is deep and liquid. The market for bitcoin futures is less deep and less liquid. As mentioned earlier, the futures contract denomination is nearing $350K. Executing the arbitrage would be cumbersome to say the least, even for large liquidity providers. Figure 7 shows the bitcoin futures price curve on 20240528. The observed prices are contained in the blue line. The theoretical futures prices are based on the implied carry rate of the 202512 futures contract, 7.7%. They are contained in the orange line. Using the 202512 implied carry rate forces the theoretical curve to match the

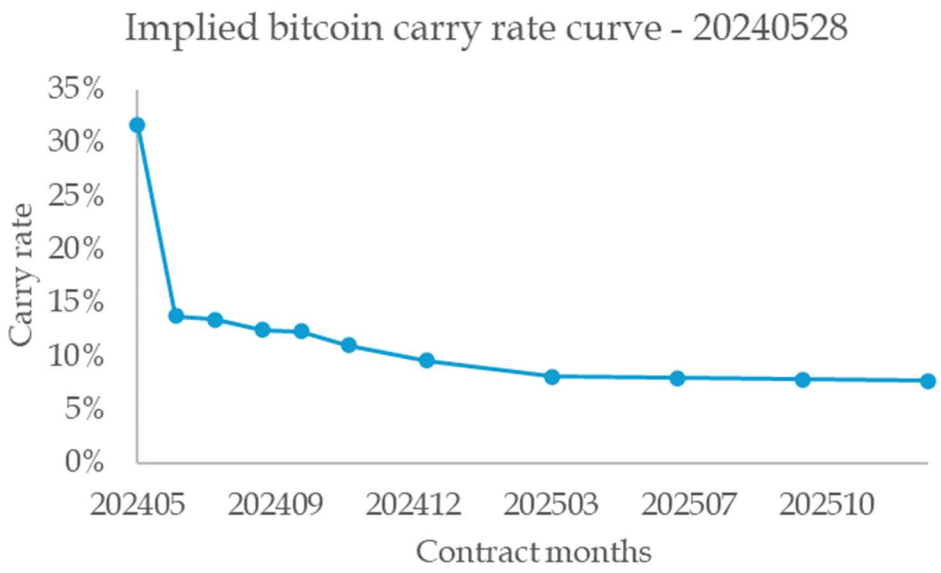
observed curve at the beginning of the series (i.e., spot bitcoin) and at the 202512 futures price (i.e., the most extended term futures contract traded on that day). The bitcoin futures market is in contango.

Figure 7: Bitcoin futures price curve at the close on Tuesday, May 28, 2024. The spot bitcoin, as well as ten bitcoin futures contracts, are shown.



The observed term structure of bitcoin futures prices can be transformed into contract-specific carry rates using equation (2). If the bitcoin futures market is a carry market, the relation should appear as a horizontal line. It does not. Figure 8 shows that the implied carry rate of the 202405 contract is 31.7%, followed by 13.8%, 13.4, and 12.5% for the June through August contracts. The longest contract, 202512, has a carry rate of 7.7%, as noted earlier. The bitcoin market appears to be a non-carry market, but why?

Figure 8: Bitcoin carry rates at the close on Tuesday, May 28, 2024. The spot bitcoin, as well as ten bitcoin futures contracts, are shown.



The answer is likely limits to arbitrage. To drive the futures price back into a carry relation, the arbitrager would have to buy spot bitcoin and sell the futures.[21] As we have already seen, the contract denomination of the bitcoin futures is large. Selling just a single bitcoin future exposes the liquidity provider to extreme risk. Bitcoin prices are extremely volatile and often spike in one direction or the other. A spike upward in the futures price would mean that the arbitrager would have to add cash to his hedged position because the futures is marked-to-market daily. Likely, the contango is driven by a liquidity premium for the inconvenience and risk of executing the arbitrage. Figure 6 shows that implied carry rate of the 202405 bitcoin futures is 31.7% and the 202406 is 13.8%. These are well more than the risk-free financing rate and storage costs.

[21] The profit from this apparent arbitrage opportunity has not gone unnoticed by the financial press. See "Traders swoop on bitcoin 'cash and carry' trade after ETF launches." *Financial Times* (January 24, 2024).

Bitcoin futures performance

To assess the economic significance of this mispricing, we can compare the returns of investing in spot bitcoin with the returns generated by a long bitcoin futures strategy. The proxy for the spot bitcoin investment is the spot index BRRNY. Standard and Poor's reports return indexes for two bitcoin futures strategies which are easily mimicked. SPBTCFUT is a fully collateralized investment consisting of T-bills and a long futures position. The futures position is exclusively in the nearby futures and is rolled each month in equal proportional amounts to the second nearby contract beginning six days, *t*-6, before the contract's expiration. In this way, the weight on the second nearby is one on day *t*-2. SPBTFDUT is also a fully collateralized bitcoin futures position, where the futures are rolled daily between the nearby and second nearby in a manner to create a constant maturity of about 30 days. Table 5 holds summary statistics for the spot and futures strategies returns since 20190102.

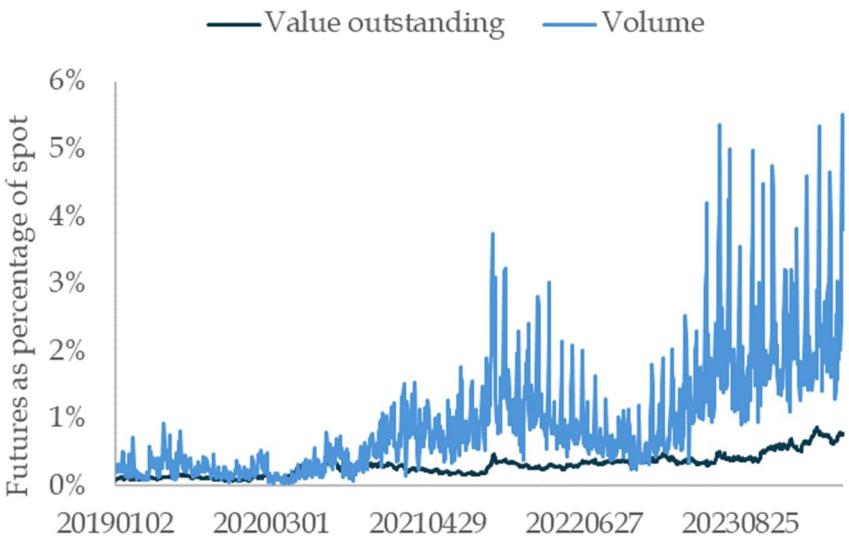
Table 5: Summary statistics for spot bitcoin (BRRNY) and bitcoin futures indexes for the period 20190102 through 20240531.

Description	BRRNY	SPBTCFUT	SPBTFDUT
No. of obs.	1,362	1,362	1,362
CAGR	70.52%	63.15%	63.86%
Volatility	65.56%	68.20%	68.37%
Correlations			
BRRNY	1	0.984	0.984
SPBTCFUT	0.984	1	1.000
SPBTFDUT	0.984	1.000	1

As the table shows, the spot return is higher. BRRNY has a CAGR of 70.5%, while the CAGRs of SPBTCFUT and SPBTFDUT are 63.2% and 63.9%, respectively. The differences are attributable to the contango observed in the bitcoin futures market. While all strategies are influenced by the spot bitcoin return, the futures returns are lower because their prices are too high and must converge downward toward the spot price as their

lives grow short. The return volatilities are higher for the futures (68.2% and 68.4%) than the spot (65.6%). The intuition here is that the futures market is neither as deep nor as liquid as the spot market. Trades of any size have more price impact causing higher observed volatility. This is also reflected in the pairwise return correlations. While the correlation between the futures indexes is near perfect, the returns of the futures indexes with the spot index are not. Figure 9 shows the dollar value of bitcoin futures outstanding as a percentage of spot. It never exceeds 1% during the period 20190102 through 20240531. For dollar volume, it does not exceed 6%.

Figure 9: Bitcoin futures as a percentage of spot—daily dollar value outstanding and daily dollar trading volume—during period 20190102 through 20240531.



4.3 Futures-based bitcoin ETFs and their expected performance

The analysis of the bitcoin futures performance compared to spot bitcoin is compelling. The futures market is consistently in contango, causing bitcoin futures-based indexes to perform poorly. We now turn to the performance of ProShares BITO since its launch on 20211018. As said in its Fact Sheet on March 31, 2024:

> "BITO seeks investment results, before fees and expenses, that correspond to the performance of bitcoin."

With a management fee of 0.95%, the return performance should be about 100 basis points lower than BRRNY.[22] Such is not the case. Using the daily return data for 20211019 through 20240531, we compute summary statistics. The results are reported in Table 6. The total number of daily returns is 657. All return series are slightly skewed to the left, meaning the likelihood of a significant price drop is somewhat higher than a large increase. The minimum and maximum returns confirm this interpretation. The medians are near 0%, which suggests that the expected daily return of bitcoin is about 0%. The levels of serial correlation are also near 0, indicating that bitcoin prices have no memory. The correlation of BITO's returns with BRRNY, 0.978, is less than with the S&P bitcoin futures total return index, 0.999. The difference reflects the fact that BITO's replication strategy uses bitcoin futures rather than spot bitcoin.

The annualized statistics reflect performance. Over the period, BITO comes well short of achieving the results of bitcoin after fees and expenses. The CAGR of BRRNY was 2.17%, and BITO was –3.46%, a 563-basis point difference. The return of SPBTCFUT[23] was –0.18%, 2.35% lower than BRRNY. This reflects the persistent contango of the bitcoin futures market. BITO's return was –3.46%, 3.28% lower than the futures index. Subtracting BITO's expense ratio of 0.95%, this futures-based ETF experiences a deadweight added cost of 2.33%, likely due to an ineffective replication strategy.

Insights regarding ProShares's futures trading can be gathered from the daily holdings of BITO published on the ProShares website. Figure 10 is reproduced from Whaley (2022, Fig. 2) and shows the daily futures holdings of BITO from product launch on 20211019 through 20220522. During this sample period, BITO held only the two nearby bitcoin futures. The nature of the figure suggests that ProShares holds as much of the nearby futures contract that they are allowed, given the CME's position limit of 4,000

[22] In fairness to ProShares, they do not appear to have a benchmark index – spot bitcoin or futures bitcoin.
[23] The SPBTCFUT is based on a five-day roll, from *t*-6 to *t*-2 before the last trade date of the nearby futures. This approach closely resembles ProShares's stated roll methodology.

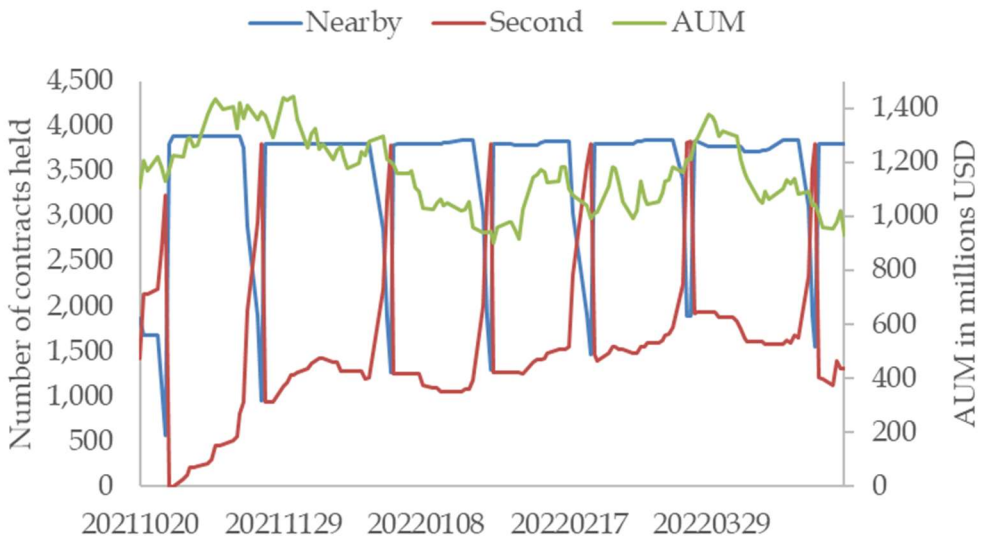
contracts. Any residual need for contracts needed from new net inflows are consummated with purchases of the second nearby. Once the nearby futures reach a week or so to expiration, ProShares appears to roll out of the nearby into the second nearby over three or four days. To the extent that ProShares' replication strategy varies from our benchmark index, small return differences may appear. But the differences cannot account for the 200-basis point difference.

Table 6: Summary statistics for daily returns of CME CF Bitcoin Reference Rate (BRRNY), S&P CME Bitcoin Futures Index (SPBTCFUT), and ProShares Bitcoin Strategy ETF (BITO) since BITO's launch on 20211019.

Period:	20211020	20240531	
No. of obs.:	657		
		Indexes	
Daily statistics	BRRNY	SPBTCFUT	BITO
Mean	0.009%	-0.001%	-0.014%
Standard deviation	3.514%	3.745%	3.753%
Skewness	-0.23	-0.21	-0.22
Minimum	-22.191%	-22.414%	-22.593%
Median	0.036%	-0.045%	-0.053%
Maximum	19.648%	20.114%	20.140%
Serial correlation	0.02	-0.02	-0.02
Correlation			
BRRNY	1	0.978	0.978
SPBTCFUT	0.978	1	0.999
BITO	0.978	0.999	1
Annualized statistics			
CAGR	2.17%	-0.18%	-3.46%
Volatility	55.78%	59.45%	59.58%
Differences			
CAGR*		-2.35%	-5.63%
Volatility*		3.67%	3.80%

*Differences are from BRRNY. E.g., -0.18% - 2.17% = -2.35%.
Difference in CAGR for BITO from SPBTCDUT is -3.28%.

Figure 10: BITO futures holdings and $AUM from 20211019 through 20220522.



5. Summary of conclusions

Four main conclusions may be drawn from this study. First, the most sensible way for investors to buy bitcoin is through spot bitcoin ETFs. While buying bitcoin on cryptocurrency exchanges is cost-efficient and may be done on a 24/7 basis, spot bitcoin ETFs are a safer, more familiar, and more convenient way to invest long-term. Second, synthetically creating spot bitcoin returns using a fully collateralized futures position will always produce less return and more risk than spot bitcoin. The bitcoin futures market is persistently in contango, and the depth of the futures market is limited. Lack of depth means added risk. The risk of the futures position is the sum of spot bitcoin risk and futures basis risk. Third, futures-based bitcoin ETFs will perform even poorer than bitcoin futures. They add management fees and replication strategy risk.

Finally, the ultimate goals of financial innovation will always relate to creating social value and protecting investors. The importance of diligent communication among regulators, fund managers, and other parties involved in this process should be based on

facts and logic applied through constructive dialogue. The experience with spot bitcoin ETFs could have been better. Can we learn?

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Appendix 1: Daily return summary statistics for spot bitcoin ETFs, futures-based BITO and spot bitcoin index BRRNY from 20240102 through 20240531.

Summary

Description	ARKB	BITB	BRRR	BTCO	BTCW	EZBC	FBTC	HODL	IBIT	GBTC	BITO	BRRNY
No. of obs.	97	97	97	97	97	97	97	97	97	97	97	97
Mean (daily)	0.38%	0.38%	0.38%	0.39%	0.39%	0.38%	0.38%	0.38%	0.38%	0.40%	0.36%	0.38%
StDev (daily)	3.58%	3.59%	3.58%	3.58%	3.58%	3.58%	3.61%	3.59%	3.60%	3.56%	3.62%	3.39%
Skewness	0.12	0.15	0.14	0.14	0.16	0.15	0.12	0.13	0.13	0.14	0.14	0.25
Kurtosis	-0.05	0.04	0.03	0.00	0.01	-0.01	-0.02	0.02	0.05	0.02	0.02	0.08
Autocorrelation	-0.10	-0.10	-0.10	-0.10	-0.11	-0.10	-0.11	-0.10	-0.11	-0.11	-0.12	-0.08
Minimum	-8.86%	-8.88%	-8.97%	-8.92%	-8.89%	-8.96%	-8.98%	-8.99%	-9.01%	-8.92%	-9.02%	-7.83%
Median	0.21%	0.11%	0.20%	0.12%	0.16%	0.20%	0.20%	0.08%	0.17%	0.22%	0.20%	0.15%
Maximum	10.56%	10.77%	10.61%	10.65%	10.70%	10.62%	10.66%	10.70%	10.77%	10.58%	10.81%	10.42%
Mean (annual)	95.56%	95.24%	95.17%	97.11%	97.28%	96.18%	95.80%	95.80%	96.10%	101.28%	90.78%	95.84%
StDev (annual)	56.87%	56.94%	56.89%	56.76%	56.83%	56.84%	57.23%	57.02%	57.14%	56.49%	57.48%	53.83%
CAGR	160.03%	159.20%	159.01%	164.09%	164.53%	161.65%	160.65%	160.66%	161.44%	175.34%	147.89%	160.76%
HPR	44.46%	44.28%	44.24%	45.33%	45.42%	44.81%	44.59%	44.60%	44.76%	47.68%	41.83%	44.62%

Correlations

Tickers	ARKB	BITB	BRRR	BTCO	BTCW	EZBC	FBTC	HODL	IBIT	GBTC	BITO	BRRNY
ARKB	1	0.999	0.999	1.000	0.999	0.999	1.000	0.999	1.000	0.999	0.999	0.989
BITB	0.999	1	0.999	1.000	0.999	0.999	0.999	1.000	1.000	0.999	0.999	0.988
BRRR	0.999	0.999	1	0.999	0.999	0.999	0.999	0.999	1.000	0.999	0.999	0.989
BTCO	1.000	1.000	0.999	1	0.999	0.999	0.999	1.000	0.999	0.999	0.999	0.988
BTCW	0.999	0.999	0.999	0.999	1	0.999	0.999	0.999	0.999	0.999	0.999	0.988
EZBC	0.999	0.999	0.999	0.999	0.999	1	0.999	0.999	0.999	0.999	0.999	0.989
FBTC	1.000	0.999	0.999	0.999	0.999	0.999	1	0.999	0.999	0.999	0.999	0.988
HODL	0.999	1.000	0.999	1.000	0.999	0.999	0.999	1	1.000	0.999	0.999	0.988
IBIT	1.000	1.000	1.000	0.999	0.999	0.999	0.999	1.000	1	0.999	0.999	0.989
GBTC	0.999	0.999	0.999	0.999	0.999	0.999	0.999	0.999	0.999	1	0.999	0.987
BITO	0.999	0.999	0.999	0.999	0.999	0.999	0.999	0.999	0.999	0.999	1	0.988
BRRNY	0.989	0.988	0.989	0.988	0.988	0.989	0.988	0.988	0.989	0.987	0.988	1